Enjoyment, Boredom, Anxiety in Elementary Schools in Two Domains: Relations with Achievement

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Abstract

This study investigated the enjoyment, boredom, and anxiety of elementary school students, and the relations of these emotions with achievement in two domains. Seven-hundred-and-sixty-seven second and fourth-graders completed an adaptation of the "Achievement Emotions Questionnaire-Elementary School" (AEQ-ES: Lichtenfeld, Pekrun, Stupnisky, Reiss, & Murayama, 2012) assessing their emotions in their native language and mathematics. The hierarchical model of the instrument was invariant across countries (Italy, US, Germany), grades, gender, and domains. Anxiety related negatively to achievement, while enjoyment related positively to achievement only in mathematics. Second-graders reported more enjoyment, and less boredom and anxiety than fourth-graders. Fourth-grade boys reported less enjoyment, and more boredom and anxiety than girls in their native language. The results have implications for future research on achievement emotions in elementary school.

Keywords: Achievement, Domain Learning, Elementary schools, Emotional Development, Factor Analysis, Multivariate (Classical)

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When engaged in learning, students feel a range of emotions depending on individual differences, the school subject (i.e., domain), the academic settings (e.g., during lessons, when doing homework, or taking a test), and on various other characteristics of the contexts in which they arise (Pekrun, Goetz, Titz, & Perry, 2002). Contemporary educational psychology has paid increased attention to achievement emotions, as well as individual differences and contextual factors as emotional precursors, due to their recognized relevance in student career choice, well-being, and achievement (Pekrun & Linnenbrink-Garcia, 2014).

Achievement emotions are prospective, concurrent, or retrospective reactions to learning activities or outcomes. According to Pekrun's (2006) control-value theory of achievement emotions, students' "appraisals of control over actions and outcomes" (i.e., perceived control), and the "perceived degree of importance for oneself" (i.e., value) are central antecedents of achievement emotions (Pekrun & Perry, 2014, pp. 124-125). Accordingly, varying levels of control and value elicit discrete emotions such as enjoyment (high control, high value), boredom (low value), or anxiety (high value, low control).

Despite the believed importance of achievement emotions in all learning contexts, only a few studies have considered elementary school students' emotional experiences (Pekrun & Stephens, 2012). One reason may be the scarcity of instruments devised to measure students' achievement emotions at young ages (for an exception, see Lichtenfeld, Pekrun, Stupnisky, Reiss, & Murayama, 2012). In addition, few studies have focused on elementary school students' emotions across different domains (e.g., Mason & Stipek, 1989; Raccanello, Brondino, & De Bernardi, 2013). Therefore, the aim of this study was to investigate the extent to which elementary school children experience enjoyment, boredom, and anxiety in two different domains (native language and mathematics) and within three academic settings (attending class,

doing homework, and taking tests). We focused on second and fourth-grade students to investigate differences between early and later elementary school years, thus providing further validation data of the Achievement Emotions Questionnaire-Elementary School (AEQ-ES: Lichtenfeld et al., 2012) which originally considered only second and third-graders' emotions in the domain of mathematics. Moreover, we looked at emotions and their differences both in native language and mathematics to further extend the use of the instrument across different domains.

In the Italian educational context, elementary students are taught native language and mathematics as two distinct disciplines, with separate teachers and specific timetables for each of the domain. As for the lessons, while mathematics instructions are unique from other subjects, it is worth noting that native language teaching modalities refer to various activities, such as silent and aloud reading, worksheets, spelling, etc., in accordance with national guidelines. Characteristics of homework activities can vary by teacher, but they usually involve individual work assigned every day with varying due dates (i.e. teachers assign homework every day, sometimes for the day after or for the following days). Both domains are characterized by oral and/or written tests, administered more frequently for older rather than younger students. As for the contents of tests, teachers prepare them following national guidelines, but can vary extensively from one institute to another, from one class to another, and are not uniform in different schools. If tests are written, they can include open or closed-ended questions to assess text comprehension for native language, or calculations for mathematics. Oral exams can consist of reading a text or reciting a poetry for native language, or solving problems for mathematics.

Grade, Gender, and Domain Differences in Achievement Emotions

Research on factors explaining how and why young students experience different achievement emotions across different domains is currently lacking. The empirical literature on

emotions has documented the existence of some grade, gender, and domain differences, although mainly among older students (for a review, see Pekrun & Stephens, 2012).

Grades and achievement emotions. Most of the previous studies examining achievement emotions have been done with university or secondary school students (e.g., Goetz, Nett, Martiny, Hall, & Pekrun, 2012; Goetz, Pekrun, Hall, & Haag, 2006; Niculescu, Tempelaar, Dailey-Hebert, Segers, & Gijselaers, 2016; Putwain, Larkin, & Sander, 2013) and only rarely with elementary school students (Lichtenfeld et al., 2012; Raccanello et al., 2013). Many researchers have focused on anxiety, suggesting increases over time, i.e. as grade level increases (for a review, see Pekrun & Stephens, 2012). Raccanello et al. (2013) considered a wider variety of achievement emotions to find fourth-graders, compared to seventh-graders, express higher levels of positive emotions such as enjoyment, pride, relief, and relaxation, and lower levels of negative emotions such as boredom and anger, while no differences in hope, anxiety, guilt, and hopelessness were found. A recent study by Vierhaus, Lohaus, and Wild (2016), however, found that this negative emotional trajectory can only be found in respect to class-related emotions, i.e. those emotions emerging during lessons.

Gender and achievement emotions. Gender differences in achievement emotions have also been investigated, although mainly with secondary school students and in the domain of mathematics. Several studies found that girls reported more anxiety (Bieg, Goetz, Wolter, & Hall, 2015; Else-Quest, Hyde, & Linn, 2010) as well as more hopelessness and shame (Frenzel, Pekrun, & Goetz, 2007) than boys. Less is known on gender differences in elementary school students and some contradictory results have been found. Most of the studies focused solely on mathematics, confirming for example that in Germany not only older, but also elementary school girls experience higher levels of math anxiety and boredom, and less enjoyment and pride as compared to boys (Lichtenfeld et al., 2012; Lohbeck, Nitkowski, & Petermann, 2016). However, in an American sample of boys and girls differed only in respect to boredom and not anxiety

(Lichtenfeld et al., 2012). Likewise, a study by Harari, Vukovic, and Bailey (2013) with American first-graders from high-minority schools found no gender differences for mathematics anxiety. Given that most of the studies examining gender differences were in the mathematics domain, their findings may be specific to math or the science, technology, engineering, and mathematics (STEM) field, while other domains such as arts and language might produce different results.

Domain and setting in relation to achievement emotions. Past research suggests a need to consider domain (including native language and not only mathematics), beyond grade (the span from first to fifth-grade–in the Italian context, elementary school is five years long–is high) and gender as characterizing a range of emotions beyond anxiety. In addition, the focus of our study was on native language and mathematics also because they are the two main subjects for elementary school children. It is worth noting that the two domains differ on some aspects, such as the skills necessary to tackle verbal and scientific tasks (Boekaerts, Otten & Voeten, 2003), the associated motivational constructs such as self-concept, self-efficacy, task-value, or causal attributions, which differ to a greater extent as students' age increases (Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Wigfield & Eccles, 2000), and the corresponding stereotypical beliefs, mirroring girls' superiority for language and boys' superiority for mathematics (Bieg et al., 2015; Muzzatti & Agnoli, 2007).

Based on the control-value theory (Pekrun, 2006) and numerous supporting studies, achievement emotions and their cognitive and motivational antecedents are organized in domain-specific ways. Specifically, achievement emotions and their antecedents have been found to differ across learning domains such as reading, writing, mathematics, and science (e.g., Gogol, Brunner, Preckel, Goetz, & Martin, 2016; Pekrun & Perry, 2014). For example, secondary school students have been found to differentiate between domains when referring to antecedents of emotions such as their self-efficacy, self-concepts, task-values, attributional

beliefs, or achievement goals in English, Korean, mathematics, and science (Bong, 2001, 2004). Likewise, students distinguish between emotions such as enjoyment, pride, boredom, anxiety, and anger related to many different school subjects, such as Latin, German, English, mathematics, and physic (Goetz, Frenzel, Lüdtke, & Hall, 2011; Goetz, Frenzel, Pekrun, & Hall, 2006; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Goetz et al., 2012). In addition, Goetz et al. (2012) found that eighth and eleventh-graders experience differing levels of enjoyment, pride, boredom, anxiety, and anger when referring to different domains, but also when referring to different classroom activities or homework, thus suggesting that it is important to assess emotions separately in each setting as well as in different domains. However, prior studies did not consider elementary school students, leaving open the question if younger students distinguish between different school subjects as well as between different achievement settings in these early years.

Among the few studies investigating elementary school students, Lichtenfeld et al. (2012) found that second and third-graders reported more enjoyment, as well as less anxiety and boredom. Students' emotional patterns were also more adaptive (i.e., more enjoyment, less anxiety, less boredom) during lessons compared to during tests or homework, thus highlighting the importance of considering the achievement setting in which emotions are measured. That study, however, included only second and third-graders (not older elementary school students) and only emotions related to mathematics. In addition, boredom was not assessed as a test emotion and it was not assessed at all for second-graders. Other findings, considering a wider variety of achievement emotions with elementary to secondary school students, found higher levels of enjoyment and pride, and lower levels of guilt, boredom, and hopelessness for mathematics compared to native language (Raccanello et al., 2013). Even if the authors demonstrated that for students the distinction between domains is more salient compared to the distinction between settings, their findings indicated that, also for elementary students,

evaluative settings such as written and oral tests were associated with higher levels of hope, anxiety, guilt, and hopelessness, while non-evaluative settings such as lessons and homework were characterized by higher levels of enjoyment, relief, relaxation, and boredom. A limitation of those results was the use of single-item measures. In addition, further studies indicated that, even if between domain relations are weak in general, domain specificity increases with age (Goetz et al., 2007). Therefore, it is still debatable if elementary school students can differentiate between emotions across different subject domains and settings.

Limited current knowledge on emotions, such as focus on the mathematics domain, using only single item measures, and contradictory prior results show a need for further empirical investigations into achievement emotions. Comparing mathematics and native language domains is particularly relevant in light of the fact that they can be associated with stereotypes related to gender (Muzzatti & Agnoli, 2007). More knowledge on this issue could be highly applicable to increasing accurate inferences on students' emotional experiences from one subject to the other. Therefore, in this study we focused on three elementary student emotions (enjoyment, boredom, and anxiety), in two domains (native language and mathematics), and across three settings (lessons, homework, and tests), to assess differences between grades and genders, as well as relations to academic achievement.

Achievement Emotions and Achievement

Achievement emotions may influence learning by having an impact on functional mechanisms such as working memory capacity, information processing, and self-regulation (for overviews see Pekrun, 2006; Pekrun & Perry, 2014). Reviews of empirical studies show beneficial links for positive activating emotions, such as enjoyment, with achievement by promoting affect-related memory effects, interest, deep attention, and flexible learning strategies. Alternatively, the links with achievement are typically negative for negative deactivating emotions such as boredom, which depletes attention, motivation on the task, and

deep information processing. Inconsistent relations with achievement are typical for positive deactivating emotions such as relief, which undermines focused attention and depth of information processing. Similarly, negative activating emotions such as anxiety can reduce cognitive resources but influences motivation in an ambiguous way.

Relations between emotions and achievement have been documented mainly in studies of secondary school (Van der Beek, Van der Ven, Kroesbergen, & Leseman, 2017) and university students (Ranellucci, Hall, & Goetz, 2015). Fewer studies examined the relations between achievement emotions and achievement in elementary school children, and the results were inconclusive. Goetz, Frenzel, Hall, and Pekrun (2008) reported that in fifth to tenth-graders enjoyment and achievement were linked positively within domains (mathematics or verbal language) and negatively across domains, so that performance in mathematics predicted negatively enjoyment in language and performance in language predicted negatively enjoyment in mathematics. A study by Mason and Stipek (1989) reported stability in the relations between elementary school children achievement in reading and mathematics with emotions such as feeling smart, proud, dumb, and nervous across one school year. However, they used single-item measures, did not compare mean frequencies related to the two domains, and did not consider two emotions frequently assessed in studies using Pekrun's (2006) control-value theory: enjoyment and boredom.

Boredom–an unpleasant and low physiologically arousing emotion–has been only recently been paid attention in the literature despite its potential relevance to dropout (for a review see Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010), and reciprocal linkages with achievement, at least in college students (Pekrun, Hall, Goetz, & Perry, 2014). Compared to other emotions, boredom is also well suited for measurement scales that utilize drawings of faces, as in the case of the AEQ-ES. Enjoyment is particularly relevant because, in comparison with anxiety and boredom, empirical evidence shows it is highly domain-specific (Goetz,

Frenzel, et al., 2006). Considering these emotions, Lichtenfeld et al. (2012) found that elementary school students' mathematics-related enjoyment is linked positively, and boredom and anxiety negatively, to their achievement. However, they considered only the mathematics domain and boredom was not measured in all the considered settings (i.e., no items assessed it in the 'taking tests' setting). This study aimed at adding to the research literature by investigating elementary students' emotions both in the domain of the native language and in mathematics, as well as by including test-related boredom.

Measurement of Achievement Emotions in Elementary School Students

Enjoyment, boredom, and anxiety are emotions measured in the AEQ-ES (Lichtenfeld et al., 2012), which is a self-report questionnaire based on the Achievement Emotions Questionnaire designed for older students (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). The AEQ-ES consists of 28 items covering affective, cognitive, motivational, and/or behavioral components of emotions related to mathematics in elementary school children pertaining to lesson, homework, and test settings. The questionnaire yielded good reliability and structural validity in a sample of German second and third-graders in the domain of mathematics. It has also been validated with American third-graders, showing its measurement invariance across countries (Lichtenfeld et al., 2012).

However, researchers have yet to use the instrument to investigate if emotions and their interrelations function in a similar manner across different domains, focusing on the invariance of its structure according to factors such as different grades, gender, or domains. This could also be due to the fact that the AEQ-ES is a relatively new instrument, and studies on translated versions (beyond the German and the American versions related to mathematics, used with second and third-graders) including data on invariance across countries have not been published yet. Invariance analysis is a key step in the validation of an instrument to a new context (Kline, 2016; Ziegler & Bensch, 2013); specifically: "testing measurement invariance becomes an

interesting and indispensable issue within the translation process" (Ziegler & Bensch, 2013, p. 82). Therefore, the current study tested invariance across country, including secondary data from German and American samples (Lichtenfeld et al., 2012) and new data on Italian students gathered through the present research. Documenting it is a key step in interpreting the "psychometric soundness" of a translation (Ziegler & Bensch, 2013, p. 82).

Verifying measurement invariance is essential to make new findings more interpretable, in order to check whether results are attributable to group differences or measurement issues (Ziegler & Bensch, 2013). In other word, supporting the goodness of the measurement model of a measure is essential before running possible further analyses to avoid construct bias (Kline, 2016). Thus, when examining grade, gender, and domain differences in achievement emotions, it becomes relevant to investigate the invariance across these factors of the instrument deputed to measure them.

Research Questions and Hypotheses

The first aim of this work was to further test the AEQ-ES by examining its structural invariance across countries, grades, gender, and domains (Research Question 1). We also examined how much enjoyment, boredom, and anxiety second and fourth-graders feel in two domains of native language learning and mathematics (Research Question 2). Moreover, relations between emotions and achievement within and across domains were examined (Research Question 3).

Research Question 1. Our first research question was about the validity of the AEQ-ES. Lichtenfeld et al. (2012) confirmed its psychometric properties with German and American third-graders considering only one domain: mathematics. The first aim of this study was to extend those results by considering also fourth-graders' emotions in both native language learning and mathematics. In line with the original AEQ-ES findings (Lichtenfeld et al., 2012), a second-order hierarchical model that distinguishes between different settings (attending class,

doing homework, and taking tests) each emotion (enjoyment, boredom, and anxiety) was hypothesized to best represent the structure of the data for both the native language as well as the mathematics domain (Hypothesis 1a). The hierarchical model was expected to yield a better fit to the data as compared to two alternative models, in which valence (i.e., with positive and negative items loading on two separate latent factors) or emotion type (i.e., with enjoyment, boredom, and anxiety items loading on three separate latent factors) were included. Additionally, we expected the original AEQ-ES structure to be equivalent across three countries, namely Italy, Germany, and the US; finally, invariance was expected across grades and gender for the native language and mathematics, as well as across domains (Hypothesis 1b).

Research Question 2. The second research question was, are there mean differences for enjoyment, boredom, and anxiety related to grade (second and fourth), gender, and domain (native language and mathematics)? In line with previous findings, we expected second-graders to report higher levels of enjoyment and lower levels of boredom and anxiety compared to fourth-graders (Hypothesis 2a). We also expected girls, compared to boys, to experience more enjoyment and less boredom and anxiety in native language learning and to the mathematics domain (Hypothesis 2b).

Research Question 3. With our third research question we asked, do enjoyment, boredom, and anxiety relate to achievement? In both the native language and mathematics domains, we hypothesized enjoyment to be positively related to achievement, and boredom and anxiety to be negatively related (Hypothesis 3a). Moreover, based on previous findings on domain specificity of emotions, we expected relations between emotions and achievement to be stronger within a domain than between emotions in one domain and achievement in the other domain (Hypothesis 3b).

Method

Participants

The sample included 767 elementary school students attending grade 2 (n = 370) or grade 4 (n = 397) in 60 classes at 19 schools in Northern Italy, representing a wide variety of socio-economic backgrounds. Mean age was 7.08 years (SD = 2.10) for grade 2 (55% girls), and 8.86 years (SD = 2.78) for grade 4 (53% girls). Students had written parental consent to participate and were guaranteed anonymity. The data concerning emotions was gathered at the beginning of the second term of the school year, and those concerning achievement at the end of the second term. Reference data for testing invariance across countries were kindly made available by the authors of the AEQ-ES (Lichtenfeld et al., 2012). The data included 595 German students attending grade 3 (mean age = 10.10 years; SD = 0.72; 49% girls) and 163 US students attending grade 3 (mean age = 8.69 years; SD = 0.42; 58% girls).

Measures

Achievement emotions. We developed an Italian version of the AEQ-ES (Lichtenfeld et al., 2012) by means of a back-translation procedure, from English to Italian and back from Italian to English. The Italian adaptation included all the existing 28 items on enjoyment (nine items), anxiety (12 items), and boredom (seven items), referring to the three settings of attending class (class-related), doing homework (homework-related), and taking tests (test-related). In addition, we added four items about boredom during tests by adapting existing AEQ-ES items, which were not included in the original version, to measure the intensity of the same three emotions in all three settings. Given that the original version considered only the domain of mathematics, we added the native language domain by adjusting the items accordingly.

The Italian version of the AEQ-ES, therefore, was comprised of 32 items for each domain (64 items total), of which nine related to enjoyment (four items for lessons, e.g., *I enjoy math class*; two items for homework, e.g., *When I do math homework, I am in a good mood*; and three items for tests, e.g., *I look forward to math tests*), 11 to boredom (four items for lessons, e.g., *I find math class so boring that I would rather do something else*; three items for

homework, e.g., *When I do math homework, I get tired quickly because I am bored*; and four items for tests, e.g., *Math tests bore me*), and 12 to anxiety (four items for lessons, e.g., *During math class, I worry that everything is too difficult for me*; three items for homework, e.g., *Math homework scares me so much that I don't want to start doing it*; and five items for tests, e.g., *I get nervous during math tests*). For each item, intensity of emotions was rated on a 5-point Likert scale (1 = *not at all* and 5 = *very much*), supported by drawings of faces corresponding to increasing levels of intensity (Lichtenfeld et al., 2012). All verbal labels and pictorial materials were matched to children's gender, with a different version for boys and girls, to ensure that children could identify themselves with the faces. Items were grouped to enhance item salience to each domain and setting; specifically, for each domain we first presented class-related items, then homework-related items, and finally test-related items. Every section of the questionnaire was preceded by a written label specifying the domain and setting, and a drawing depicting a cartoon character busy within one of the three settings; namely, a dragon standing with a worksheet in one hand for lessons, a mouse laying staring at a book for homework, and a duck sitting at a desk with a pen and a sheet of paper for tests. It took about 45 minutes for the students to complete the questionnaire. Given that the length of the questionnaire could have been associated to fatigue for the participants, we gave them the possibility to stop whether they requested it, and then to begin to answer again after a brief pause.

Reliability of each factor was determined by calculating Omega as these analyses do not require tau-equivalence (i.e., that each indicator variable contributes equally to the factor) or uncorrelated error variances. Omega values ranged from .61 to .93, and from .68 to .93, for the three emotions in the native language and mathematics domains, respectively (see Table 1).

Achievement. We asked teachers to report students' grades separately for native language and mathematics as included in their final report card, assigned at the end of the second

term of the school year. In the Italian education system, grades range from 1 (very poor) to 10 (excellent).

Procedure

The Local Ethical Committee for Psychological Research of the University of Padova (n. 1613) approved the research project. Among the children whose parents agreed to their participation, two investigators led students in completing the AEQ-ES on three consecutive weeks, once a week, in classroom sessions lasting about one hour each. Like in the original study of the AEQ-ES, all items were read aloud and children were told that there were no right or wrong answers and to respond honestly. To ensure that the students understood how to respond to the questionnaire items, we added a familiarization phase for each emotion (e.g., *Hiking in the mountains bores me*), which were outside the school context to avoid interferences. After completing the examples, the students were asked to share their answers to solve possible misunderstandings concerning how to respond to the items. Order of the domain (native language, mathematics) was counterbalanced across classes. At the end of the study, each child received a diploma as a gift for his/her participation. Students were tested during school time on two consecutive days. The data considered here were only from the second session during which students responded to the AEQ-ES.

Reference data for testing invariance across countries referred to a first study for the German sample and to a second study for the US sample published by Lichtenfeld et al. (2012).

Data Analysis

We used Mplus version 6.11 (Muthén & Muthén, 1998–2011) to run Confirmatory Factor Analyses (CFA), tests of Measurement Invariance (MI), and Path Analyses (PA), controlling for biases due to a clustering effect given that children were grouped by class. The nested nature of the data was taken into account by utilizing the <type=complex> option in Mplus (Muthén & Muthén, 1998–2011), which uses maximum likelihood estimation with robust

standard errors (MLR) to estimate model parameters. This syntax is quite demanding in the estimation process. We used one-tailed tests for the PA given that the hypotheses were mono-directional (level of significance: $p < .10$). Before conducting the PA, we checked the adequacy of the sample size. It is worth noting that we had the permission to gather achievement data for only for 424 Italian students. According to Kline (2016) the minimum ratio between numbers of observations and numbers of parameters should be 5:1 or more, and preferably 10:1. A preliminary analysis, however, showed that the minimum ratio requested to run Structural Equation Models (SEM) was not met: The first two general models required 112 parameters to be estimated resulting in a ratio of only 3.79 cases for each parameter. The models also had many factors and in one case a first order factor with less than three items (larger samples are recommended under these conditions; Kline, 2016). Therefore, we applied PA for the first two general models examining the three emotions together, separated by domain. Then, the same analyses focusing on each emotion separately in the different settings were calculated to permit a coherent comparison with the two overall models, separated by domain (see Figure 2a for the overall models and Figure 2b for the models separated by domain).

We used the R version 3.3.2 (R Core Team, 2016) to run Linear Mixed Models (LMM; for similar applications see Raccanello, Burro, Brondino, & Pasini, 2017), to investigate differences in emotions based on grade (second-graders, fourth-graders), gender (males, females), and domain (native language, mathematics). We utilized the lmer function in the lme4 package (Bates, Mächler, Bolker, & Walker, 2015). We performed Mixed Model ANOVA Tables via likelihood ratio tests (afex package; Singmann, Bolker, Westfall, & Aust, 2016) and reported effect sizes as conditional R^2 (MuMIn package; Barton, 2016; Nakagawa & Schielzeth, 2013). We utilized Gaussian family and identity link-function. For post-hoc tests we used the Bonferroni correction with the Satterthwaite's approximation for degrees of freedom (lsmeans package; Lenth, 2016). Participants and class were used as random effects. The level of

significance was $p < .05$. Preliminary analyses (LMM) revealed no significant effects of grade, gender, or domain on achievement.

Results

Preliminary Analyses

We verified that skewness (range: 0.03-2.80, mean value 1.10) and kurtosis (range: 0.00-7.32, mean value 1.35) values for each item did not exceed 2.0 and 7.0 (except one item), respectively, supporting normality assumptions (Curran, West, & Finch, 1996). We also analyzed missing values in the data, which revealed the maximum percent of missing values for items was 3%, and only 11% of the cases registered any missing values. Little's MCAR test indicated that data were missing at random, $\chi^2(2962) = 4217.30$, $p < .001$.

Descriptive statistics appear in Table 1, which includes intercorrelations, number of items, possible range, observed range, means, and standard deviations for grade, gender, achievement emotions by setting, and achievement, separated by domain (native language and mathematics). The emotions felt in the three settings and two domains inter-correlated, and many relations were found with achievement, mainly in mathematics and in the native language as for anxiety.

Validation of the AEQ-ES in the two Domains and Measurement Invariance (MI)

We ran two separate CFAs, one for each domain, to test the goodness of fit of the hypothesized structure, considering the class to which children belonged as the clustering variable. We tested a hierarchical second-order model distinguishing between the three settings for each emotion (Figure 1). To investigate goodness of fit, we used the comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the standardized root mean square residual (SRMR), with CFI $\geq .90$, RMSEA $\leq .08$, and SRMR $\leq .10$ as threshold values (Kline, 2016). The results of the CFAs supported the hypothesized structure. All factor loadings were positive and statistically significant (larger than .58 and .60, respectively for the native

language and mathematics) and the goodness of fit indexes were acceptable (native language/mathematics: $\chi^2(452/453) = 1572.34/1410.20$, CFI = .93/.93, RMSEA = .06/.05, SRMR = .06/.05), supporting Hypothesis 1a.

We compared goodness of fit of the hierarchical model to that of two alternative models. First, a two-factor model in which positive items loaded on a latent positive emotion factor and negative items loaded on a latent negative emotion factor (native language/mathematics: $\chi^2(463/463) = 4445.25/3257.10$, CFI = .74/.79, RMSEA = .11/.09, SRMR = .10/.08). Second, a three-factor model in which enjoyment, boredom, and anxiety items loaded on three different latent factors, respectively (native language/mathematics: $\chi^2(461/461) = 3013.03/2454.41$, CFI = .83/.85, RMSEA = .08/.08, SRMR = .07/.06; see also Lichtenfeld et al., 2012 for this approach). None of these models showed acceptable fit to the data, thus supporting the hypothesized hierarchical structure, further supporting Hypothesis 1a.

For each domain, MI analyses examined hypotheses on the invariance of the factorial structure across countries, grades, and gender. In addition, we checked for the invariance across domains, splitting our dataset randomly (balancing both grade and gender). We performed multigroup CFAs by testing separate nested CFA models, including: (1) the configural invariance model, allowing all the parameters to be freely estimated; (2) the metric invariance model, requiring invariant factor loadings; and (3) the scalar invariance model, additionally requiring invariant intercepts. Comparisons among models were based on differences in CFI, RMSEA, and SRMR: Support for invariance requires a change in CFI less or equal than .010, a change in RMSEA less or equal than .015, and a change in SRMR less or equal to .030 for testing metric invariance and less or equal to .010 for testing scalar invariance. We reported the three indexes (see Table 2) but, as suggested by Chen (2007), we considered the change in CFI as the main criterion.

To test invariance across countries, we ran separate analyses comparing the Italian sample with the German and US samples only for the mathematics domain, given that the original data referred to that domain. The covariance matrix was negatively defined due to the small negative variance of homework-related anxiety, so the variance of this factor was restricted to .001. The results of the sequence of gradually more restrictive tests of MI supported configural, metric, and scalar invariance across all countries. It is worth noting that the scalar invariance was met only when freeing the intercept of one anxiety item. We conducted the same analyses across grades, gender, and domains and the findings suggested invariance (configural, metric, and scalar invariance) across all groups. The hypothesized measurement model was thus found to be invariant and generalizable for emotions across countries for mathematics, across grades and genders both for the native language and mathematics, and across domains (Hypothesis 1b).

Grade, Gender, and Domain Differences in Emotions

For each domain, responses to items on the same emotion and setting were averaged together, thus forming nine variables. We ran three LMM, separately for each emotion, with grade (second-graders, fourth-graders), gender (males, females), and domain (native language, mathematics) as fixed effects and emotions as dependent variables (enjoyment: R^2_c =.35; boredom: R^2_c =.32; anxiety: R^2_c =.38). See Figure 3 for mean values and standard errors.

Regarding enjoyment, we found significant effects for grade, $X^2(1) = 29.40$, $p < .001$, and domain, $X^2(1) = 32.04$, $p < .001$. Specifically, second-graders ($M = 3.59$, $SD = 0.94$) reported higher levels of enjoyment than fourth-graders ($M = 2.98$, $SD = 0.93$), and students reported lower levels of enjoyment in the native language learning ($M = 3.13$, $SD = 1.21$) compared to mathematics ($M = 3.41$, $SD = 1.21$). However, results yielded two significant two-way interactions, grade x domain, $X^2(1) = 16.70$, $p < .001$, and gender x domain, $X^2(1) = 14.12$, $p < .001$, as well as a significant grade x gender x domain, $X^2(1) = 4.21$, $p = .040$, three-way

interaction. The post-hoc tests related to the three-way interaction revealed that, concerning grade differences, both second-grade boys, $t(182.60) = 5.96$, $p < .001$, and girls, $t(151.31) = 5.13$, $p < .001$, reported higher levels of enjoyment for native language compared to fourth-graders, whereas only second-grade girls, $t(153.48) = 3.57$, $p = .013$, reported higher levels of enjoyment in mathematics as compared to fourth-grader girls. As for domain differences, enjoyment was lower in native language as compared to mathematics only for boys, $t(754.25) = -7.81$, $p < .001$, and girls, $t(174.82) = -4.92$, $p < .001$, in fourth-grade.

In respect to boredom, we found significant differences according to student grade, $X^2(1) = 16.28$, $p < .001$, gender, $X^2(1) = 4.80$, $p = .028$, and domain, $X^2(1) = 16.04$, $p < .001$. Second-grade students reported lower levels of boredom ($M = 1.79$, $SD = 0.89$) compared to fourth-graders ($M = 2.27$, $SD = 0.93$), and students reported more boredom in the native language ($M = 2.14$, $SD = 1.19$) compared to mathematics ($M = 1.95$, $SD = 1.15$). Again, results yielded two significant two-way interactions, grade x domain, $X^2(1) = 18.56$, $p < .001$, and gender x domain, $X^2(1) = 7.44$, $p = .006$. Analyses of the post-hoc tests indicated grade differences only for boredom relating to the native language, $t(82.41) = -5.39$, $p < .001$ (second-graders: $M = 1.78$, $SD = 1.03$, fourth-graders: $M = 2.48$, $SD = 1.23$). Gender differences also emerged, with boys reporting more boredom ($M = 2.10$, $SD = 0.94$) than girls ($M = 1.99$, $SD = 0.93$), but again this effect was limited to native language, $t(1411.90) = 3.41$, $p = .004$ (boys: $M = 2.27$, $SD = 1.23$; girls: $M = 2.03$, $SD = 1.15$). Domain differences were found only considering fourth-graders, $t(754.42) = 6.04$, $p < .001$ (native language: $M = 2.48$, $SD = 1.23$, mathematics: $M = 2.07$, $SD = 1.17$), and boys, $t(761.93) = 4.53$, $p < .001$ (native language: $M = 2.27$, $SD = 1.23$; mathematics: $M = 1.93$, $SD = 1.18$), with boredom higher for native language.

For anxiety, we found a significant main effect of grade, $X^2(1) = 10.88$, $p < .001$: Second-graders ($M = 1.64$, $SD = 0.65$) were less anxious compared to fourth-graders ($M = 1.85$, $SD = 0.68$). Moreover, the two-way interactions of grade x domain, $X^2(1) = 9.89$, $p = .002$, and gender

x domain, $X^2(1) = 10.33$, $p = .001$, were significant. Finally, results yielded a three-way interaction of grade x gender x domain, $X^2(1) = 4.64$, $p = .031$. On the whole, grade differences were only found for boys in respect to the native language-related anxiety, $t(243.03) = -3.89$, $p = .004$. Also domain differences emerged: More anxiety was reported for the native language compared to mathematics, $t(752.51) = 4.55$, $p < .001$. But this was only the case for fourth-graders boys.

To sum up, our data supported Hypothesis 2a on grade differences, and partially Hypothesis 2b on gender and domain differences.

Achievement Emotions and Achievement

We first conducted a PA to examine if the three emotions related to achievement, considering the two domains in the same model (Figure 2a), for the subsample of the 424 Italian students. Anxiety in native language learning ($\beta = -.11$, $p = .022$) and mathematics ($\beta = -.29$, $p = .006$) was negatively linked to achievement in the native language, with 10% of the variance explained. Enjoyment in mathematics ($\beta = .20$, $p = .047$) was positively linked to achievement in mathematics, and anxiety in mathematics ($\beta = -.27$, $p = .011$) and in the native language ($\beta = -.14$, $p = .010$) was negatively linked to achievement in mathematics, with 14% of explained variance. In sum, anxiety negatively related to achievement in both domains while enjoyment positively related to achievement in mathematics only, partially supporting Hypothesis 3a. Moreover, anxiety in the native language negatively related to achievement in mathematics and anxiety in mathematics negatively related to achievement in the native language, suggesting that anxiety is a rather pervasive emotion affecting achievement beyond the domain it is felt in (differently from what expected according to Hypothesis 3b).

Additionally, to further investigate the set of relations within domains (Hypothesis 3a), we carried out six PAs for each setting and each domain (Figure 2b). For enjoyment and boredom, only test-related emotions were statistically significant in relation to achievement, and

only for mathematics: Test-related enjoyment (β = .14, p = .086) was positively related with achievement, while test-related boredom (β = -.22, p = .064) was negatively related, with 3% and 6% of explained variance respectively. Alternatively, anxiety was linked to achievement in both domains. In native language learning, class-related anxiety (β = -.18 p = .002) and test-related anxiety (β = -.25, p = .003) negatively related with achievement, while homework-related anxiety (β = .15, p = .024) positively related to achievement, in total explaining 8% of the variance. In mathematics, only test-related anxiety was statistically significant in relation with achievement (β = -.36, p < .001), with 11% of the variance explained.

Discussion

In the current study, we investigated elementary school students' enjoyment, boredom, and anxiety during lessons, homework, and tests, as well as the relations of the emotions with achievement in native language learning and mathematics. The results extended the AEQ-ES (Lichtenfeld et al., 2012) to a domain beyond mathematics, specifically native language learning, examined more grade differences (i.e. fourth-graders), and added boredom-related items pertaining to the test setting. Below we discuss the main results, and their implications for theory and practice.

Measuring Emotions in Elementary School Students

Our first research question focused on examining the psychometric properties of the AEQ-ES to test its validity in a new context and for a new domain. The results supported the proposed hierarchical model of achievement emotions. Invariance tests further revealed that the AEQ-ES can be used to assess enjoyment, boredom, and anxiety of elementary school students in both domains of native language and mathematics, in different grades and among different genders. Extending the findings of the original study in which elementary school students' emotions were found to be invariant across German and US samples (Lichtenfeld et al., 2012), our data revealed measurement invariance in mathematics across three different countries (Italy,

Germany, and US), thus suggesting that the structure of achievement emotions is comparable across these different countries. This further supports the proposition of the control-value theory (Pekrun, 2006) that the fundamental structures as well as the underlying mechanisms of emotions are based on general nomothetic principles, whereas contents, frequency, and intensity of emotions were found to differ across cultures, genders, and individuals.

Grade, Gender, and Domain Differences in Achievement Emotions

Regarding student emotion differences across grades, the present study found mean level differences in students' enjoyment, boredom, and anxiety. In line with previous research (e.g., Raccanello et al., 2013) results showed younger students generally reported higher levels of enjoyment and lower levels of boredom and anxiety as compared to older elementary students, with some exceptions. Changes in academic tasks and classroom organization, psychological development concurrent to physiological modifications, and changes in peer relationships may be responsible for the fact that older students experience less enjoyment and more boredom and anxiety towards different school subjects (Eccles & Roeser, 2011). These results are in line with results from longitudinal research showing a decline in motivation and related affective dispositions in the transition from elementary to high school (e.g., Bong, 2009; Paulick, Watermann, & Nückles, 2013; Raccanello & Brondino, 2016; Wigfield & Eccles, 2002).

These findings urge significant adults like teachers, psychologists, and parents to reflect on practical ways to prevent downward emotional trajectories in students such as reduced enjoyment and increased boredom and anxiety that characterize learning environments. Both parents and teachers should foster a positive emotional climate associated with learning tasks to reduce this maladaptive trend. Moè (2016), who found teachers' enthusiasm about their teaching affected both students' motivation and recall, demonstrated the relevance of such attention within classes. Also important to student emotions is parents displaying high levels of positive

affect in the homework context (Pomerantz, Wang, & Ng, 2005) and transmitting intrinsic motivation (Katz, Kaplan, & Buzukashvili, 2011).

In addition to differences across grades, the current findings also revealed differences in emotions across gender. However, gender differences only emerged for the native language domain, for which boys reported to be more bored than girls. A potential underlying mechanism explaining these differences is the extent to which children endorse gender-stereotypical beliefs that expect girls to be better in verbal tasks and boys in mathematics, or adults'–parents or teachers'–beliefs about gender specificity of mathematics vs. language, which we did not measure. In other terms, on the bases of the control-value theory we can assume that expectations of being better–even expectations due to stereotypical beliefs of adults significant for children–leaded to differences in emotions, with control appraisals responsible for that as central antecedents of emotions. Practitioners could work on reducing stereotypic beliefs, especially for boys in native language, or enhancing control appraisals.

Finally, we found that children felt differently in respect to the different school domains, thereby filling gaps in the literature which has neglected this issue. Native language learning was found to be less enjoyable for fourth-graders, more boring both for fourth-graders and boys, and more anxiety provoking only for fourth-grade boys. Results on enjoyment and boredom parallel previous findings on native language and mathematics with older students (Raccanello et al., 2013). The finding that, overall, mathematics resulted in better emotions than native language could be related to different factors, among which the way teachers talk about these content areas. Often teachers know the importance of convincing young kids of the importance of STEM and thus focus on trying to generate excitement, engagement, and rationales for mathematics, and maybe this could not be the case for native language. In addition, utility value may be highlighted more in mathematics compared to native language–and value beliefs are key appraisals for achievement emotions. Basing on our findings, interventions focused on

promoting utility value (e.g., Rozek, Svoboda, Harackiewicz, Hulleman, & Hyde, 2017) could foster positive emotions and discourage negative ones in the native language domain. Future studies should disambiguate whether this effect is particular to the Italian context or can be generalized to other countries. On the whole, our findings suggest that taking into account situational characteristics is essential to adequately describe psychological processes associated with learning, and specifically emotional processes.

Documenting how different emotions vary their intensity according to the kind of domain could also give specific indications at an applied level. It could encourage professionals such as teachers, psychologists, or educators to acknowledge that, although the structure of emotions in different domains is the same, intensity with which emotions are felt in different domains can vary extensively from one student to another.

Relations Between Emotions and Achievement

Finally, a central aim of the study was to examine the relations of enjoyment, boredom, and anxiety with achievement. We first examined within-domain relations. In line with the theoretical model (Pekrun, 2006; Pekrun & Perry, 2014) and previous research with elementary school children in mathematics (Lichtenfeld et al., 2012), the current study results showed anxiety correlated negatively while enjoyment positively correlated with achievement, while in the native language domain only anxiety was negatively linked to achievement. We found no significant relations between boredom and achievement in this study. Interestingly, the results yielded across-domain relations between students' anxiety and achievement: Anxiety experienced in the native language was negatively linked to achievement in mathematics, and anxiety felt in mathematics negatively related with the level of achievement in the native language. This indicates that anxiety may be a very pervasive emotion that spreads to different domains, thereby negatively influencing performance.

Beyond supporting findings from the vast literature on the role of anxiety for school performance (e.g., Pekrun & Stephens, 2012), our findings extended it taking into account the role of settings. As expected, class-related and test-related anxiety were negatively linked to achievement. Surprisingly, the present study yielded positive relations between homework-related anxiety and achievement, suggesting that worries activated in a non-evaluative setting during homework (different from the evaluative setting in which grades are obtained), in which the social component is less salient, differ in respect to their consequences in performance outcomes. A plausible mechanism that may account for this difference, could be that anxiety experienced in a non-evaluative setting may be functional in enhancing students' extrinsic motivation and thereby enhancing students' effort invested. During homework students reported boredom more than anxiety and more than doing tests or attending lessons. Therefore, anxiety felt in this boring setting of homework time could be functional towards a display of effort and prevents lack of accomplishment or giving up early. Relations between achievement and the other two emotions, namely enjoyment and boredom, were quite weak and only were significant in the test setting.

Overall, teachers and parents may interpret these data as encouragement to make children anxious during homework despite the subsequent negative effects during test taking. However, fear appeals have been experimentally demonstrated as teaching strategies damaging for learning (e.g., Putwain & Best, 2011). We also highlight that the mean level of anxiety was quite low. These are not highly anxious children, which is encouraging, but also cautions teachers and parents against making children highly anxious because these results are based on low levels of anxiety in the first place.

In summary, our findings suggest that anxiety plays a complex role in students' achievement. Our results highlight the relevance of considering both domain-specificity as well

as different school settings when measuring emotions, especially in view of future intervention studies aimed at favoring more adaptive emotional patterns.

Limitations, Implications, and Future Directions

A primary limitation of the present research is the use of self-report measures, which could have favored social desirability effects. Future work should extend these findings by assessing emotions considering other indicators such as facial expressions, by videotaping lessons, or taking into account other-reports such as from parents or teachers. A further limitation is that there was only one measurement point in time for each construct, namely, emotions and achievement; in other words, we used a cross-sectional rather than a longitudinal research design. This aspect relates to the assumption of construct stability, given that we measured achievement emotions during the term and data on achievement were gathered at the end of the term. Together with taking into account the young age of our participants, these issues further solicit the importance of caution in the interpretation of construct representativeness and stability. Future longitudinal studies should include more measurement points to assess reciprocal relations between students' emotions and their achievement going beyond these limitations. Another limitation is that classroom related factors were not included in the study. These factors, like characteristics of teaching (e.g., displayed enthusiasm, students' involvement), teachers' motivations (e.g., self-efficacy, self-determined motivation), as well as the capabilities the team of teachers has, may be important antecedents of emotions and foster students positive affect and intrinsic motivation. This study also utilized path analyses with single indicators, which usually have poor psychometric properties and assume error free measurement of the variables. This is especially problematic in respect to independent variables being affected by measurement error as it biases the parameter estimates. Further limitations of path analyses in general regard issues related to the underlying assumptions (e.g., the absence of correlations between residuals and preceding variables, or the interval scale of the variables) or

to the meaning of the model fit (e.g., significant paths do not demonstrate the causal nature of relations), and, for our specific path analyses, the limited number of manifest variables per latent variable (Jeon, 2015). Finally, relations between emotions and achievement were only analyzed for a sub-sample due to missing achievement data for part of the sample. Thus, future studies would be well advised to include larger samples to replicate these findings.

Conclusions

At any school level, students experience different emotions in their school subjects and the different achievement settings they are facing. For elementary school students, emotions were assessed using the AEQ-ES, a self-report instrument whose hierarchical structure has been demonstrated as invariant across three countries, different grades and gender, and across domains. Anxiety was found to be linked both to achievement in the same domain as well as to achievement in another domain, while both enjoyment and boredom showed few linkages with performance. Older students were found to show a more maladaptive emotional pattern than younger students, marked by lower enjoyment as well as higher boredom and anxiety. Focusing on students' emotions and developing instruments to assess them in reliable ways is a very important step, which can provide innovative contributions to our knowledge of the emotional factors that are important in specific school contexts. In addition, research in this area enable a deepening understanding about how young students experience their emotions differently according to grade, gender, and domains. Finally, these results could help teachers, practitioners, and parents to verify the efficacy of their teaching methods or ways of supporting them, in order to ascertain whether they have a positive impact on students' emotions in the academic setting.

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Table 1

Intercorrelations, Number of Items, Possible Range, Observed Range, Means (M), Standard Deviations (SD), and Omega Values for Age, Gender, Achievement Emotions by Setting (Class, Homework, Test), and Achievement, for each Domain (Native Language, Mathematics)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Age in months	--																					
2. Gender	.04	--																				
3. Class-related enjoyment – Native language	-.14***	.10**	--																			
4. Homework-related enjoyment – Native language	-.13***	.12***	.78***	--																		
5. Test-related enjoyment – Native language	-.12***	.04	.69***	.73***	--																	
6. Class-related boredom – Native language	.11**	-.10**	-.84***	-.65***	-.54***	--																
7. Homework-related boredom – Native language	.11**	-.11**	-.71***	-.76***	-.57***	.80***	--															
8. Test-related boredom – Native language	.14***	-.08*	-.67***	-.66***	-.65***	.76***	.81***	--														
9. Class-related anxiety – Native language	.03	-.03	-.44***	-.33***	-.35***	.53***	.47***	.46***	--													
10. Homework-related anxiety – Native language	-.02	-.07	-.36***	-.41***	-.37***	.43***	.53***	.49***	.69***	--												
11. Test-related anxiety – Native language	.09**	.00	-.36***	-.36***	-.52***	.39***	.45***	.52***	.64***	.68***	--											
12. Achievement – Native language	-.05	.15**	.04	.00	.06	-.11*	-.07	-.09	-.21***	-.12*	-.25***	--										
13. Class-related enjoyment – Mathematics	-.08*	-.04	.15***	.21***	.20***	-.08*	-.13***	-.10**	.00	-.05	-.09*	.11*	--									
14. Homework-related enjoyment – Mathematics	-.12***	-.03	.26***	.38***	.32***	-.18***	-.26***	-.24***	-.03	-.09**	-.11**	.11*	.77***	--								
15. Test-related enjoyment – Mathematics	-.09*	-.11**	.15***	.24***	.39***	-.07	-.12***	-.19***	-.02	-.07*	-.20***	.19***	.71***	.70***	--							
16. Class-related boredom – Mathematics	.09*	.01	-.13***	-.17***	-.13***	.17***	.20***	.19***	.12**	.13***	.14***	-.15**	-.85***	-.64***	-.58***	--						
17. Homework-related boredom – Mathematics	.09*	-.01	-.15***	-.23***	-.18***	.21***	.30***	.32***	.15***	.20***	.20***	-.18***	-.72***	-.74***	-.59***	-.79***	--					
18. Test-related boredom – Mathematics	.11**	.05	-.11**	-.18***	-.19***	.18***	.27***	.34***	.18***	.22***	.28***	-.21***	-.68***	-.63***	-.69***	.76***	.81***	--				
19. Class-related anxiety – Mathematics	.03	09.*	.04	.02	-.03	.03	.06	.07	.29***	.23***	.28***	-.22***	-.55***	-.40***	-.44***	.65***	.56***	.59***	--			
20. Homework-related anxiety – Mathematics	.03	.06	.05	-.03	-.03	.02	.10**	.13***	.22***	.34***	.31***	-.21***	-.52***	-.49***	-.48***	.60***	.65***	.65***	.72***	--		
21. Test-related anxiety – Mathematics	.10**	.11**	.06	.00	-.11**	.02	.07	.15***	.23***	.26***	.41***	-.32***	-.53***	-.45***	-.64***	.57***	.60***	.73***	.72***	.75***	--	
22. Achievement – Mathematics	-.04	.09	.00	.01	.08	-.07	-.06	-.07	-.20***	-.10*	-.25***	.84***	.19***	.15***	.27***	-.21***	-.22**	-.26***	-.28***	-.22***	-.37***	--
Number of items	--	--	4	2	3	5	3	4	3	3	5	--	4	2	3	5	3	4	3	3	5	--
Possible range	--	0-1	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-10	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-10
Observed range	83-131	0-1	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	6-10	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	6-10
M	96.02	--	3.40	2.95	3.04	2.03	2.23	2.16	1.54	1.68	2.06	8.37	3.73	3.18	3.32	1.81	2.06	1.96	1.53	1.65	2.05	8.50

SD	31.50	--	1.34	1.40	1.26	1.23	1.33	1.29	0.75	0.90	0.98	1.18	1.29	1.43	1.3	1.15	1.29	1.26	0.8	0.93	1.09	1.21
Omega	--	--	.93	.80	.82	.93	.89	.92	.72	.61	.79	--	.92	.76	.85	.91	.89	.93	.73	.68	.84	--

Note. $N = 767$, with the exception of intercorrelations with achievement, for which $N = 424$. Achievement was measured according to Italian grades.

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 2

Results of Invariance Analyses across Country (Italy, Germany, US) for Mathematics, across Grade (Second, Fourth-Graders) and Gender (Boys, Girls) for Native Language/Mathematics, and across Domain

Groups	Model	χ^2	df	*p*	CFI	RMSEA	SRMR	Δ CFI	Δ RMSEA	Δ SRMR
Country	Italy (n = 767)	1529.09	453	.001	.928	.056	.065	–	–	–
	US/Germany (n =163/595)	554.07/842.93	339/339	.001/.001	.923/.927	.063/.050	.060/.055	–	–	–
	Configural invariance	1361.17/1529.09	680/680	.001/.001	.932/.931	.060/.056	.058/.065	–	–	–
	Metric invariance	1430.09/1645.32	700/699	.001/.001	.928/.927	.061/.054	.064/.061	.004	.000	.006/.005
	Scalar invariance	1510.00/1880.30	728/727	.001/.001	.922/.918	.062/.057	.068/.064	.009	.003	.004/.003
Grade	Second-graders (n = 370)	886.65/977.00	453/452	.001/.001	.925/.911	.051/.057	.061/.059	–	–	–
	Fourth-graders (n = 397)	1230.96/1078.20	453/453	.001/.001	.915/.931	.066/.059	.079/.058	–	–	–
	Configural invariance	2142.02/2039.80	907/906	.001/.001	.918/.918	.060/.057	.072/.059	–	–	–
	Metric invariance	2138.82/2131.44	929/929	.001/.001	.919/.921	.058/.059	.072/.062	.001/.003	.002/.002	.000/.003
	Scalar invariance	2301.74/2212.42	961/961	.001/.001	.911/.917	.060/.059	.098/.067	.008/.004	.002/.000	.005/.026
Gender	Boys (n = 353)	864.08/1017.41	451/452	.001/.001	.945/.925	.051/.059	.065/.068	–	–	–
	Girls (n = 414)	954.07/1654.24	452/453	.001/.001	.938/.902	.052/.081	.064/.060	–	–	–
	Configural invariance	2176.36/1967.02	907/906	.001/.001	.917/.923	.060/.056	.070/.058	–	–	–
	Metric invariance	2144.97/1983.16	927/929	.001/.001	.922/.924	.059/.055	.069/.059	.005/.001	.001/.001	.001/.001
	Scalar invariance	2197.31/2054.73	961/961	.001/.001	.921/.921	.058/.055	.072/.061	.001/.003	.001/.000	.003/.002
Domain	Native language (n = 386)	1211.51	453	.001	.906	.068	.072	–	–	–
	Mathematics (n = 376)	1009.65	453	.001	.920	.057	.058	–	–	–
	Configural invariance	2202.86	907	.001	.913	.061	.066	–	–	–
	Metric invariance	2219.79	929	.001	.914	.060	.067	.001	.001	.001
	Scalar invariance	2281.94	961	.001	.912	.060	.070	.002	.000	.003

Note. df = degrees of freedom; CFI = comparative fit index; RSMEA = root-mean-square error of approximation; SRMR = standardized root mean square residual; Δ CFI/RSMEA/SRMR = change in CFI/RSMEA/SRMR.

Figure 1. Factorial structure of the hierarchical model, in which the nine first-order factors are the three emotions (enjoyment, boredom, and anxiety) evaluated in the three settings (class, homework, test), and the second-order factors are the three emotions. We did not report the exact number of items per factor (see Table 1 for the exact number of items). E = enjoyment, B = boredom, A = anxiety.

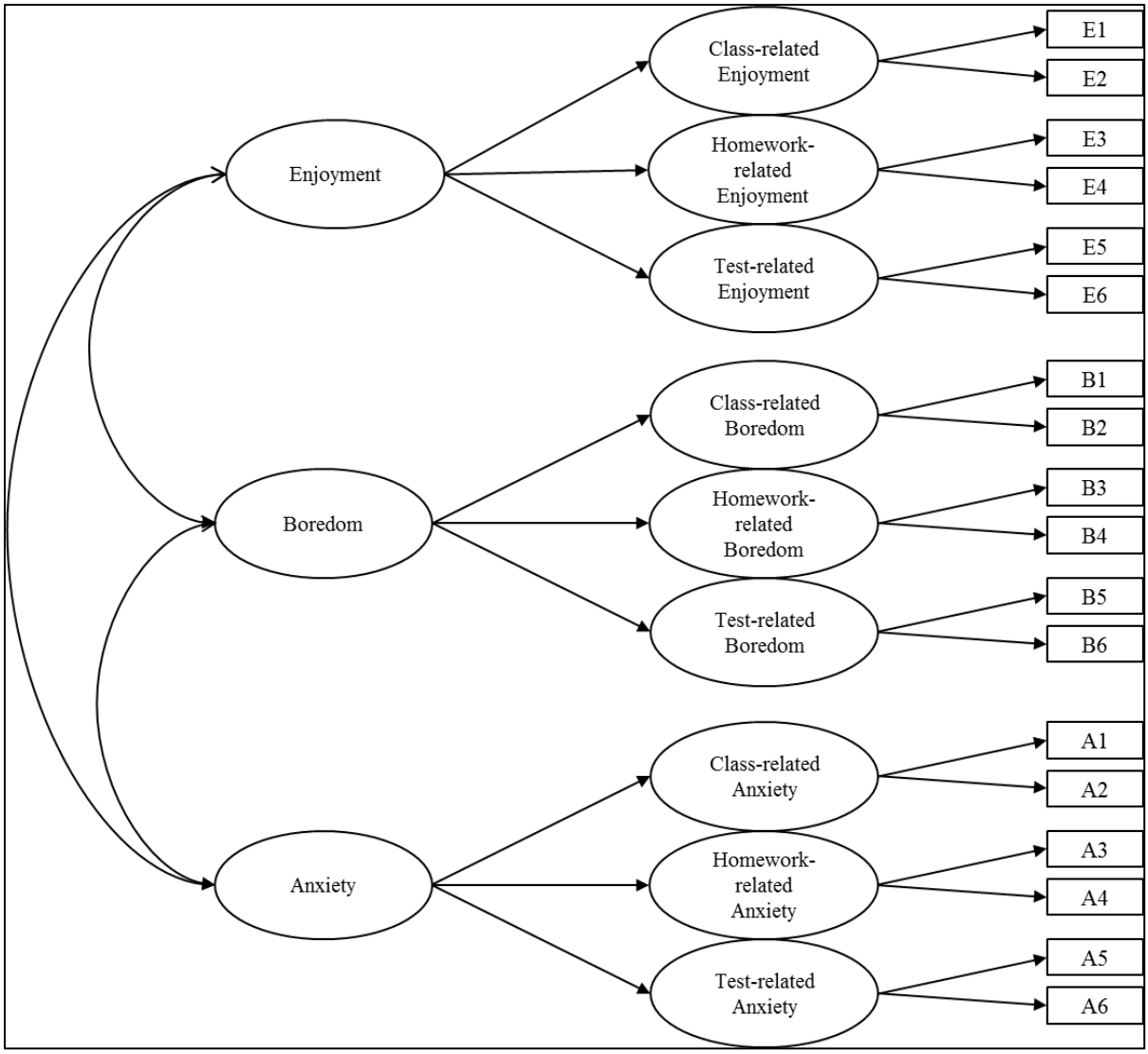

Figure 2. Path analyses for relations of achievement emotions with achievement: overall (Figure 2a) and separated by domain (native language/mathematics) and setting (Figure 2b). We reported explained variances next to each dependent variable.

°$p < 0.10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Figure 2a

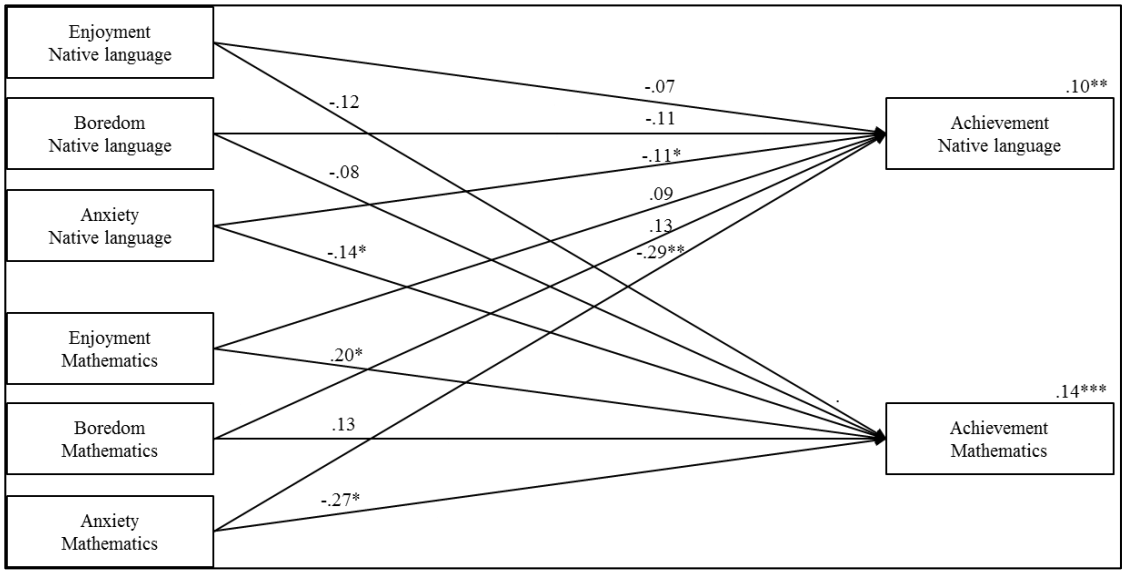

Figure 2b

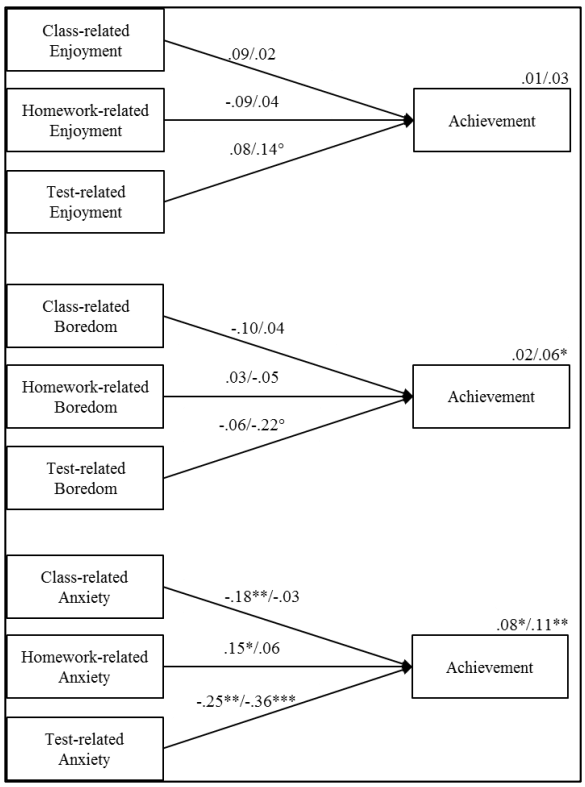

Figure 3. Means of enjoyment, boredom, and anxiety by grade (second-graders, fourth-graders), gender (boys, girls), and domains (native language, mathematics). The bars are standard errors.